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Career and Technical Education as a Strategy to Improve Long-term Outcomes for English Language Learners

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Career and Technical Education (CTE) has emerged as a strategy to enhance college and labor market outcomes for all students, yet little is known about its implications for multilingual students classified as English Learners (ML-ELs). Using longitudinal data from Massachusetts, this study provides some of the first evidence on ML-ELs' CTE participation and its relationship with long-term outcomes. Findings reveal that ML-ELs engage in CTE at lower rates than peers, driven by both inter- and intra-school disparities. We also find a positive association between CTE participation and postsecondary enrollment and earnings, suggesting that CTE may be an effective strategy to support language learners' success beyond high school.

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One in ten public school students in the United States is an English Learner, indicating that they require additional support to fully engage with instruction in English. Multilingual students classified as English learners (ML-ELs)[1] hold rich linguistic, cultural, intellectual, and familial capital (Núñez et al., 2016). They also face substantial barriers to success: in addition to typically having lower proficiency or literacy in English, ML-ELs are more likely to experience interrupted education (Custodio & O'Loughlin, 2020) and may encounter biases from teachers and peers due to their language backgrounds (Dabach, 2014; Umansky & Dumont, 2021). It is thus not surprising that ML-ELs graduate from high school and enroll in college at lower rates than peers (Kanno & Cromley, 2013; Zaff et al., 2021).

Identifying interventions that states and districts can leverage to improve long-term success for ML-ELs is vitally important. While a body of research focuses on instructional models for ML-ELs (Kibler & Castellón Palacios, 2022; Umansky & Reardon, 2014) or on the effects of English learner (re)classification (Carlson & Knowles, 2016; Johnson, 2019), few studies consider interventions that specifically target college or career outcomes for these students. Given ML-ELs' unique characteristics—particularly lower levels of English proficiency on average—programs that work well for other minoritized groups may not generalize to this population (Johnson & Mercado-Garcia, 2022). There is a need for more empirical evidence around strategies to improve language learners' postsecondary trajectories.

[1] We use the term "ML-EL" as an assets-based way to refer to the subset of multilingual students who are officially identified for English Learner services (Bartlett et al., 2024). When referring to specific services or policies, we use the adjective "EL" to mirror the language used in federal guidelines.

Career and Technical Education (CTE) is a popular initiative that aims to improve employment and earnings outcomes through courses focused on technical career fields (Hemelt et al., 2019). CTE is offered at both the postsecondary and secondary levels, with high schoolers typically taking CTE classes as electives at traditional schools or through specialized CTE academies. Historically viewed as a "dumping ground" for low-performing students, high school CTE in the U.S. increasingly focuses on preparing students for both college and career (Dougherty, 2018, p. 123). Since 1984, the federal government has directed billions of dollars to states to support CTE programming through the Carl D. Perkins Career and Technical Education Act. Provisions in recent reauthorizations of the Perkins Act require states to identify and address gaps in CTE access for special populations of underserved students, including ML-ELs (Reauthorization of Carl D. Perkins Act, 2018). Despite these requirements, research on CTE for ML-ELs is currently limited.

In this paper, we use Massachusetts administrative data from 2007-2019 to offer some of the first evidence on high school CTE engagement for ML-ELs and its association with long-term outcomes. Several recent studies leverage quasi-experimental designs like regression discontinuity and instrumental variables to measure the causal impact of CTE on long-term success (see e.g. Dougherty et al. 2019; Brunner et al. 2023; Hemelt et al. 2019). However, causal analyses are typically limited to specific selective settings or populations of students who are on the margin of admission to oversubscribed programs. These settings are not representative of the typical environments in which most students in the U.S. engage in CTE: non-selective CTE academies or open-access elective classes at their local high school (Ecton and Dougherty 2023). Further, given the small size of the ML-EL population, settings that allow causal inference about CTE for ML-ELs are rare. We therefore use a descriptive design which allows us to draw on rich state-level data to characterize multiple dimensions of CTE engagement and subsequent postsecondary trajectories for all ML-ELs at all high schools in Massachusetts. We address the following research questions:

1. To what extent is English learner status associated with engagement with CTE?
2. To what extent is CTE concentration associated with improved postsecondary education outcomes for ML-ELs?
3. To what extent is CTE concentration associated with improved labor market outcomes for ML-ELs?

We find that ML-ELs in Massachusetts are 5 percentage points less likely than similar non-ELs to concentrate in CTE, a federal metric for CTE engagement defined in Massachusetts as completing at least 2 years of CTE coursework. We also find that ML-EL CTE participants accrue 23% fewer CTE credits during high school and are less likely to concentrate in construction and engineering/manufacturing, two of the career clusters with the highest earnings returns. We find a strong positive association between concentrating in CTE and improved long-term outcomes, with evidence that the correlation between CTE and educational attainment is stronger for ML-ELs than for non-EL peers. New evidence that ML-ELs in Massachusetts are systematically less likely to engage in CTE across multiple dimensions—overall participation, intensity of participation, and career field coursework—suggests that other states may also face disparities in CTE engagement for this special population. As state governments continue to invest heavily in career coursework, education leaders should identify gaps in CTE participation and success for English learners and consider strategies to address these disparities.

Existing Evidence on Differences in CTE Participation by Student Background

Detailed evidence of ML-EL CTE engagement, net of other characteristics like family income, is currently limited. However, recent research documents disparities in CTE engagement for other marginalized student groups, such as students of color and students with disabilities. During the 1980s and 1990s, students of color, low-income students, and special education students in the U.S. were systematically tracked into low-rigor vocational education programs due to racist and ableist biases (Dougherty, 2023). The conception of career coursework began to shift in the early 2000s, however, with an increasing focus on college and career readiness that positioned vocational coursework as complementary to college preparation (Dougherty, 2023). As CTE has expanded to include more programs aligned with high-paying careers and postsecondary education, emerging evidence suggests that students of color and differently-abled students are now underrepresented in CTE in some states, particularly in programs with high earnings returns like STEM (Carruthers et al., 2021; Hemelt et al., 2019). For example, a study from Massachusetts shows that students with disabilities, Black students, and Latino/a students are systematically less likely to complete CTE courses in information technology and engineering (Dougherty & Harbaugh Macdonald, 2020).

Several factors could explain these differences in CTE participation. First, many students in the U.S. access CTE through specialized high schools, community colleges, or CTE training centers, all of which require applications for admission (Ecton & Dougherty, 2023). Even though most of these programs are not selective, research shows that the administrative burden associated with application processes can dampen participation for low-income and racially minoritized families, who often have less free time, money, or relevant social capital to invest in accessing services (Herd & Moynihan, 2019; Jabbar et al., 2025). As CTE has increased in popularity, a growing number of CTE schools are oversubscribed and admit students selectively using criteria that favor White applicants, like prior disciplinary history (Ansel et al., 2022; Hemelt et al., 2019).

Another way that students can access CTE is by taking electives at their assigned, comprehensive high school (Ecton & Dougherty, 2023). However, the number and types of CTE courses available vary widely across schools (Carruthers et al., 2021). In a study of CTE participation by race across three states—Tennessee, Massachusetts, and Washington—Carruthers et al. (2021) find that students of color earn fewer CTE credits overall compared to similar White peers. Estimated differences in CTE credit accumulation attenuate when the authors compare students within the same schools, suggesting that, in these state contexts, disparities in CTE engagement by race may be largely explained by differences in the availability and quantity of CTE courses at the schools that students of color disproportionately attend.

Additional Barriers to CTE Engagement for ML-ELs

Provisions in the 2006 and 2018 reauthorizations of the Perkins Act (Perkins IV & V) require states to monitor and address gaps in CTE participation for special subgroups of students, including ML-ELs. Prior research suggests that English learner status can limit students' access to other types of courses, including electives, advanced courses, and core academic classes (Callahan et al., 2010; Callahan, 2005; Callahan & Shifrer, 2016; Estrada, 2014; Umansky, 2016a). However, evidence on CTE participation for ML-ELs is more limited.

Most ML-ELs are low-income students of color, and thus factors like administrative burden will influence CTE engagement for these students. However, even after accounting for factors like family income and race, ML-ELs face unique obstacles to CTE enrollment and success. First, as discussed above, one of the primary ways that students access CTE is through application-based schools and programs. In addition to the other barriers created by application processes, ML-ELs must often navigate formal or informal English proficiency requirements (Mavrogordato et al., 2025). For example, Mavrogordato et al. (2025) show that in Michigan, CTE programs housed at community colleges often require students to pass placement tests in English reading and writing to qualify for admission. Even though most high school-based programs do not have official language requirements, schools may still informally discourage ML-ELs from applying. In his study of a CTE-dedicated high school in Northeastern U.S., Emerick (2022) finds that administrators told students and teachers at sending schools that English proficiency was a prerequisite for applying to the CTE school, even though the official policy was open-enrollment. One administrator in Emerick's study explained that he viewed English proficiency as necessary for CTE students for safety reasons, "giving the example that if Johnny can't understand even basic instructions, like stop, somebody could get hurt" (p. 245). The counselors' comments reflect many of the biased beliefs about ML-ELs that are used to justify providing less access to traditional academic courses: that English acquisition should be prioritized over all other learning, and that it is not possible or necessary for schools to modify courses to make them more accessible to ML-ELs (such as by providing safety instructions in multiple languages or hiring bilingual aides for CTE classes) (Emerick, 2022; Estrada, 2014; Umansky & Avelar, 2023). Unsurprisingly given the messaging about language proficiency from school representatives, students in Emerick's study told him that they believed that ELs were not eligible to attend the CTE high school.

Students can also access CTE through electives at their local high school. Research shows that although the vast majority of schools serve at least one EL, due to factors like neighborhood segregation, 20% of U.S. schools serve over 75% of all ML-EL students (Quintero

& Hansen, 2021). Schools with high concentrations of ML-ELs also tend to serve large numbers of students living in poverty. ML-ELs' engagement in CTE will depend in part on the number and types of courses that are available at the schools they attend. Further, scheduling constraints are a specific barrier to CTE participation for ML-ELs. Federal law requires schools to provide ML-ELs with language supports such as English language development (ELD) courses. Within traditional high schools, both ELD and CTE usually take the place of elective courses, making it difficult for students who take one or more sections of ELD to find space for CTE (Umansky, 2016a). In particular, newcomer ML-ELs who arrive in the U.S. during high school have limited time for electives because they need to complete the required credits for graduation on a truncated timeline (Mavrogordato et al., 2025).

Even if ML-ELs enroll in career courses, CTE educators are often ill-prepared to meaningfully engage them in course content. In general, educator preparation programs provide limited training on working with ML-ELs (Leider et al., 2021). Many CTE teachers do not complete traditional educator preparation programs, meaning they are even less likely to receive substantial instruction on pedagogy for language learners (Emerick, 2022). As a result, CTE teachers may struggle to make courses accessible to ML-ELs. In their study of a half-day CTE program at a large high school in Pennsylvania, Salerno and Kibler (2015) find that newcomer ML-ELs were often placed in CTE courses that did not align with their career interests in which they were the only ML-EL student. During classroom observations, ML-ELs in the study hardly ever interacted with English-speaking peers, rarely interacted with their teacher, and were often not given the opportunity to engage in hands-on CTE coursework at all. While some of these findings may be specific to the study context, Salerno and Kibler (2015) demonstrate that simply enrolling ML-ELs in CTE is insufficient. Teachers must also be equipped to modify the curriculum to meaningfully engage ML-ELs in CTE coursework.

Finally, among the subset of ML-ELs who are undocumented, legal restrictions around employment and state certification pose another challenge. CTE programs often allow students to earn industry-recognized credentials, which require social security numbers in many states (Higher Ed Immigration Portal, 2025). In their study of Michigan, Mavrogordato et al. (2025) find examples of undocumented students completing CTE programs before realizing that they were ineligible to receive the certification needed to work in the relevant field. These negative experiences, and lack of guidance about CTE options that do not require state certifications, may deter undocumented peers from considering CTE.

In sum, ML-ELs face multiple specific barriers to CTE engagement and success. Importantly, a few studies also document examples of ML-ELs being placed involuntarily in CTE classes that were not aligned with their career aspirations (Emerick & Goldberg, 2023; Salerno & Kibler, 2015). Despite changes in CTE in recent years, a risk remains that vocational education programs will be treated as a dumping ground for student groups who are perceived to be unlikely to succeed in college. Schools and districts should ensure that no group of students is systematically tracked into CTE. Nevertheless, ML-ELs who are interested in learning about technical fields and career opportunities should have equitable access to CTE programs (Kanno, 2021b).

Evidence for a Relationship between CTE and Long-Term Outcomes Educational Attainment

A growing body of evidence links participating in modern CTE programs to improved high school attendance rates, decreased likelihood of dropout, and increased likelihood of on-time high school graduation (Bonilla, 2020; Brunner et al., 2023; Dougherty et al., 2019; Dougherty, 2018; Gottfried & Plasman, 2018; Hemelt et al., 2019; Plasman et al., 2021, 2024). Evidence around the relationship between CTE and postsecondary enrollment is more mixed, with some studies finding no effects (Gottfried & Plasman, 2018) and others finding positive effects, largely concentrated in 2-year institutions (Dougherty et al., 2019; Ecton & Dougherty, 2023). A few studies indicate a positive relationship between CTE and four-year college enrollment for specific types of CTE coursework, such as STEM courses, and specific underserved student populations, such as students of color or students with disabilities (Edmunds et al., 2022; Freeman et al., 2023; Hemelt et al., 2019; Kemple, 2008; Plasman & Myles, 2024).

Prior literature identifies several mechanisms through which CTE could increase educational attainment. First, relative to traditional academic courses, CTE classes typically emphasize more applied subject matter, use hands-on instructional techniques like project-based learning, and employ multidimensional assessments (Gottfried & Plasman, 2018; Kreisman & Stange, 2017). These different characteristics of CTE courses create new opportunities for success for some students who have struggled in traditional academic courses (Kreisman & Stange, 2017). At the same time, because students often select into CTE courses that align with their interests, participating in more interesting coursework decreases the psychic costs of remaining in school (Stevenson et al., 2021). Thus, scholars theorize that CTE improves educational persistence by increasing expected benefits of education and decreasing immediate costs (Kreisman & Stange, 2017). ML-ELs may particularly benefit from the opportunity for more hands-on, project-based learning opportunities in CTE classes. Several studies find that experiential learning increases both language acquisition and content learning for English learners (Lai, 2024; Short, 2017).

Second, CTE coursework often incorporates explicit education around career options, the pathways to different careers, and expected earnings. Studies link participation in CTE to more time spent on career planning and improved career decision-making self-efficacy (McWhirter et al., 2000; Mobley et al., 2017). Better understanding of the expected payoffs of careers in CTE fields that require high school diplomas or postsecondary degrees can increase the likelihood that students graduate high school and enroll in college. Because ML-ELs are disproportionately likely to be the first person in their family who attended college in the United States, structured career planning and mentorship opportunities in CTE programs may be important for helping these students identify postsecondary opportunities, particularly those in technical fields (Mwangi, 2018).

Labor Market Outcomes

Studies largely find a positive relationship between CTE coursework and earnings in the years immediately following high school graduation. Using a regression discontinuity design, Brunner et al. (2023) find that attending a CTE-dedicated high school in Connecticut increases average quarterly earnings for male students by 32 percent (baseline $4,500) up to 8 years after expected graduation. In a longitudinal study where students across the U.S. gained entry to oversubscribed career academies via lottery, Page (2012) finds that male students who participated in a career academy for all four years of high school earned $588 more monthly up to 8 years after graduation.

One of the ways that CTE could increase earnings is by allowing students to develop skills that increase their productivity (Brunner et al., 2023; Dougherty, 2018; Hemelt et al., 2019). Credentials or certifications earned through CTE programs can also serve as a signal of competence to employers, making it easier for students to access higher paying jobs (Brunner et al., 2023). The signal value of CTE may be particularly important for ML-ELs, who face additional barriers in the labor market because of their language background. A large, international literature on language economics links lower proficiency in a country's dominant or official language to lower earnings and higher likelihood of unemployment (Aparicio-Fenoll & Di Paolo, 2023; Chiswick & Miller, 2007, 2015; Gazzola et al., 2019). Other studies suggest that speaking with a non-dominant accent decreases the likelihood of receiving a job offer, regardless of language proficiency level (Hideg et al., 2022, 2024). For the subset of ML-ELs who have lower English proficiency or speak with a non-dominant accent, the signal value of CTE credentials could help to counteract language-based employment disadvantages. In addition, many of the industries associated with CTE coursework, such as certain skilled trades, are relatively insular (Mavrogordato et al., 2025). Students from immigrant families are less likely to have family members or friends who have previously worked in high-wage, high-demand technical fields. Through CTE, ML-ELs can access mentors with professional networks in local industries, helping them break into less accessible career fields.

Evidence on the relationship between CTE and long-term earnings outcomes is more limited. A handful of studies conducted in Sweden, Switzerland, and Israel with cohorts of students born in the 1950s-1970s show that vocational education is associated with earnings advantages in the short-term, but earnings disadvantages in the longer term (Gabay-Egozi & Yaish, 2021; Golsteyn & Stenberg, 2017; Korber & Oesch, 2019). However, these results may not generalize to the current CTE system in the U.S. Prior studies were conducted in countries with siloed vocational and academic secondary school systems and compare vocational students' outcomes to outcomes for students who attend college preparatory high schools. In the U.S., federal policy requires CTE students to complete the same college preparatory curriculum as non-CTE students, even if they attend a CTE-dedicated high school. Further, it is still too early to observe late-career labor market outcomes for many of the students who participated in CTE after the recent shift towards both college and career preparation. More research is needed to understand the long-term implications of CTE in the U.S. Existing evidence supports a variety of early and mid-career benefits of CTE, particularly for students who are on the margin of high school graduation or completing any postsecondary education. This study explores the extent to which documented benefits of CTE may also extend to ML-EL students.

Study Context

Our study context is Massachusetts, a state with a long-standing CTE system. Massachusetts has offered vocational programming through its public schools for over 100 years (Dougherty, 2018). The state has a diverse range of CTE offerings, with about one in four students completing multiple CTE courses during high school. This participation rate puts Massachusetts roughly on par with average CTE participation rates nationally (Liu & Burns, 2020). CTE students in Massachusetts have the opportunity to specialize in 11 different career clusters, which are broadly similar to the 16 national career clusters identified by Advance CTE (*Career Clusters*, 2023). Massachusetts career clusters include: agriculture and natural resources; arts and communication; business and consumer services; construction; education; healthcare; hospitality and tourism; information technology services; manufacturing, engineering and technology; and transportation.

Students in Massachusetts primarily participate in CTE in two different formats, reflecting the typical settings of career and technical coursework across the country (Ecton & Dougherty, 2023). Approximately one third of CTE participants in the state attended CTE high schools, called Regional Vocational and Technical Schools in Massachusetts (RVTS). Students in

RVTS are still required to complete the same graduation requirements as students at comprehensive high schools, so CTE takes the place of elective coursework (Dougherty, 2018). The remaining two-thirds of CTE participants enrolled in career coursework through their comprehensive high school, with CTE again taking the place of elective classes (Dougherty, 2018).

Massachusetts is also home to a large population of ML-ELs. Between 2006 and 2021, the proportion of public-school students classified as ELs more than doubled from 6 percent to 13 percent, relative to a national average of 10 percent (*Our Nation's English Learners*, 2022) . Massachusetts ML-ELs are linguistically diverse, with about half of students speaking Spanish as a home language and eleven percent speaking Portuguese, the highest proportion of Portuguese-speaking ELs of any state (*Our Nation's English Learners*, 2022). With a large population of ML-ELs and well-established CTE system, Massachusetts offers a compelling setting to study the relationship between CTE and long-term outcomes for English learners.

Data

Sample

We use data from the Massachusetts Department of Elementary and Secondary Education's Student Information Management System to address our research questions. We merge Department of Elementary and Secondary Education data with National Student Clearinghouse data, which captures credit-bearing college enrollment information for most degree-granting, Title-IV eligible institutions in the U.S. We limit our analysis to students who were enrolled in a public school in Massachusetts at any point during grades nine through twelve with expected graduation years of 2007 to 2019, but we capture information on longitudinal characteristics—such as years classified as an EL while enrolled in Massachusetts public schools—starting in first grade.

Prior research suggests that EL classification itself may constrain students' engagement with CTE through mechanisms like English language development coursework requirements and educators' biases about students labeled as English deficient. EL is a dynamic status; EL-classified students are reassessed every year and are reclassified as "Fully English proficient" once they demonstrate proficiency on English language assessments. For clarity, we exclude students who were formerly classified as ELs but reclassified out of EL status before ninth grade from our sample.[2] We compare CTE engagement and implications for "high school ML-ELs"—students who were ever EL-classified during grades 9-12—to outcomes for "never ELs," students who were never EL-classified in Massachusetts in any grade. We focused on whether students were ever EL classified in high school, rather than EL status in each grade, because many of our outcomes of interest occur across multiple years.

Seven percent of Massachusetts students during our study period were high school ML-ELs (Table 1). Although students who enter 9th grade as an EL have an opportunity to reclassify each year, the average ML-EL in our sample spent the majority of their time in high school as an EL (2.5 years on average). Fifty-six percent of high school ML-ELs were Hispanic, 83% were eligible for free or reduced-price lunch (FRPL), and 60% were born outside the U.S. The analytic sample includes 1,021,782 individuals. To allow us to observe average annual earnings up to seven years after expected high school graduation, we use a smaller sample for our earnings analyses comprised of the high school graduating cohorts of 2007-2012 (N=499,248).

Table 1. *Descriptive Statistics.*

	Never EL	HS EL

[2] Appendix Table D2 and D3 and Figure D1 present our main outcomes of interest for former ELs. We find that former ELs are slightly more likely than never EL peers to engage in CTE. These results provide suggestive evidence that disparities in CTE engagement for current ELs are driven by mechanisms specific to EL classification and service requirements (rather than, for example, immigrant identity).

Proportion all Students	88%	7%
Average Yrs EL-Classified in HS	0	2.5
Female	49%	46%
White	74%	10%
Asian	4%	14%
Hispanic	11%	56%
Black	9%	19%
Immigrant Student	1%	60%
FRPL-Eligible	39%	83%
Special Education	18%	12%
8th Grade Math Score	0.04	-0.36
8th Grade Attendance	94%	94%
% CTE Concentrators	19%	14%
Attended CTE-Dedicated HS	10%	6%
Observations	942,461	79,321

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019. Proportions of students in the first row do not sum to 100 because former EL students who reclassified before 9th grade are excluded from the sample. CTE Concentrator=Student who completed at least two years of CTE coursework, a federal measure for substantial CTE engagement.

Outcome Measures

Our first set of analyses explores how engagement in CTE coursework varies by EL status. We consider three outcomes:

- *CTE concentrator* is defined as enrolling in CTE courses for two or more years during high school. CTE concentrator is a federal metric for substantial engagement in CTE. During our study period, the definition of concentrator varied by state. We use

Massachusetts' definition of CTE concentrator in this study. Considering concentration, rather than any participation, allows us to capture the relationship between relatively sustained exposure to CTE and long-term outcomes (Ecton & Dougherty, 2023).

- *CTE cluster concentrator* is defined as a student who completed at least two years of CTE coursework within one of Massachusetts' 11 recognized career clusters.
- *Total number of CTE credits* (logged) accrued in high school, among CTE participants.

In our second set of analyses, we look at the relationship between CTE concentration and two important long-term outcomes:

- *Postsecondary enrollment* by Spring 2019, defined as enrolling in any credit-bearing coursework at a Title-IV eligible, degree-granting institution in the U.S. that reports data to the National Student Clearinghouse,
- *Average annual earnings (logged)* 3, 5, and 7 years after expected high school graduation for individuals who reported any earnings to the Massachusetts Department of Labor Unemployment Insurance System.

Because earnings data were obtained from the Massachusetts Department of Labor Unemployment Insurance System, our data only capture reported taxable earnings for non-federal employees in Massachusetts who were eligible for unemployment benefits. Thus, our data excludes some forms of earnings such as seasonal work, self-employment, some "gig economy" work, and federal employment. In Appendix Table D1, we show that high school ML-ELs are more likely than similar peers to have no reported earnings in the years after high school. If ML-ELs disproportionately work in industries not captured by our data, this would attenuate our estimates of the association between CTE and earnings.

Analytic Approach

Research Question 1: EL Status and CTE Engagement

Our first research question addresses the association between EL status and three measures of CTE engagement. We use the following model:

$$(1) CTE_{ic} = \beta_0 + \beta_1 EL_i + \boldsymbol{X'}_{\boldsymbol{ic}} + \pi_c + \varepsilon_{ic}$$

For student *i* in graduating cohort *c*. CTE_{ic} represents our CTE engagement measures of interest (concentrator, cluster concentrator, credit accumulation); EL_i is an indicator for being a high school ML-EL, relative to never EL; X'_i is a vector of student-level covariates including gender, race, eighth-grade attendance rate and scores on the first attempt of the math section of the eighth grade Massachusetts Comprehensive Assessment (MCAS), special education status, and indicators for missing eighth grade data and taking an alternative MCAS; [3] and π_c is graduating cohort fixed effects. Standard errors for all models are heteroskedasticity-robust and clustered at the school level.

In addition to our main models, we estimate a second set of models that include school-by-cohort fixed effects (σ_{sc})[4] using the following equation:

$$(2) CTE_{ics} = \beta_0 + \beta_1 EL_i + \boldsymbol{X'}_{\boldsymbol{ics}} + \sigma_{sc} + \varepsilon_{ic}$$

For student *i* in cohort *c* in school *s*. This model allows us to measure the association between EL status and CTE engagement, after accounting for the CTE opportunity available at students' high school. If we observe that any differences in statewide engagement disappear when we add

[3] We imputed missing data for attendance and math score covariates using the closest observed value to overall sample mean. Indicators for missing data control for systematic differences in which students are missing eighth grade covariates. 15% of the sample has missing 8th grade test scores and 27% has missing 8th grade attendance. We chose this method of imputation because it maintains comparability across cohorts while preserving the overall distribution of the data.

[4] Students are assigned to their ninth-grade school as their primary high school. If ninth grade school is missing, students are assigned to their 10th, 11th, 12th, or 13th grade (for repeaters) value in that order. 90% of students in the sample were assigned to the same high school every year.

school-by-cohort fixed effects, this would suggest that differential engagement in CTE is primarily explained by fewer CTE options at the schools ML-ELs typically attend (Carruthers et al., 2021).

We estimate equations 1 and 2 for three CTE engagement outcomes: concentrator, cluster concentrator, and total credits. The concentrator analyses use the full analytic sample. For the cluster concentrator analysis, we exclude students who concentrated in other clusters and thus estimate the likelihood of concentrating in a specific cluster, relative to no CTE concentration. For the credit analysis, we limit our analysis to students with any CTE participation to capture variation in the intensity of CTE engagement, conditional on enrolling in CTE. We also limit the sample to students from the 2011 to 2019 graduating cohorts as credit data are not available in all years.

Research Question 2: EL Status, CTE Participation, and Postsecondary Outcomes

We next assess whether each of our three CTE engagement measures are associated with improved postsecondary outcomes for ML-ELs. For CTE concentration, we estimate the following model:

$$(3)\ Y_{ics} = \beta_0 + \beta_1 CTE_{ics} + \beta_2 EL_{ics} + \beta_3 CTE_{ics} x EL_{ics} + \boldsymbol{X'_i} + \sigma_{sc} + \varepsilon_{ics}$$

Where Y_{ics} is postsecondary enrollment for student *i,* in cohort *c,* in school *s*. Our postsecondary enrollment measure captures any enrollment in an institution that reports data to the National Student Clearinghouse by Spring 2019. EL_{ics} is an indicator for being a high school ML-EL, relative to never EL; CTE_{ics} is an indicator for being a CTE concentrator, defined as completing two years of CTE coursework; X'_i is a vector including the student-level covariates used in equation 1 and 2; σ_{sc} is school-by-cohort fixed effects. Our coefficients of interest are β_1, which shows the estimated change in outcome for concentrators relative to non-concentrators, and β_3, which shows if the relationship between CTE concentration and the outcome of interest differs by EL status.

To estimate the association between total CTE credits completed and the likelihood of postsecondary enrollment—conditional on any CTE participation—we use the following model:

$$(4)\ Y_{ics} = \beta_0 + \beta_1 Credits_{ics} + \beta_2 Credits_{ics}^2 + \beta_3 EL_{ics} + \beta_4 Credits_{ics} x EL_{ics} + \beta_5 Credits_{ics}^2 x EL_{ics} + \boldsymbol{X'_i} + \sigma_{sc} + \varepsilon_{ics}$$

Where Y_{ics} is postsecondary enrollment and $Credits_{ics}$ are the total number of CTE credits completed during high school. We add a quadratic term and additional interaction to account for diminishing returns at high levels of CTE credit completion.

To assess the relationship between CTE cluster concentration and postsecondary enrollment, we use the following model:

$$(5)\ Y_{ics} = \beta_0 + \beta_1 Cluster_{ics} + \boldsymbol{X'_i} + \pi_c + \sigma_{sc} + \varepsilon_{ics}$$

Where Y_{ics} is postsecondary enrollment and $Cluster_{ics}$ is an indicator for concentrating in a specific career cluster. We run separate models for ML-ELs and never ELs and for each career cluster. Thus, our coefficient of interest β_1 shows the difference in postsecondary outcome for students who concentrated in each cluster, relative to students in the same language group who did not concentrate in CTE.

Research Question 3: EL Status, CTE Participation, and Earnings Outcomes

Finally, we re-estimate equations 3-5 using a set of earnings outcomes: annual earnings (logged) 3, 5, and 7 years after expected high school graduation. We limit our analysis to students who report any earnings to the UI system but show robustness of results to including those who report zero earnings (Appendix C Table C3). We also limit the sample for these analyses to the graduating cohorts of 2007-2012 to allow us to observe 7 years of earnings data for all students in the sample. We discuss generalizability of our findings below.

Results

RQ 1: Disparities in CTE Engagement by EL Status

We first explore the relationship between EL status and CTE engagement. Our results suggest that ML-ELs are systematically less likely than similar non-EL peers to concentrate in CTE; ML-EL CTE participants accrue substantially fewer CTE credits on average; and ML-ELs are slightly less likely than peers to concentrate in several career clusters, including clusters associated with high earnings returns. Preliminary evidence suggests that disparities in CTE engagement may be driven by both differences in CTE offerings between schools and barriers to participation within schools.

CTE Concentration

In Table 2 Column 1 Panel A, we estimate that high school ML-ELs are 5 percentage points less likely than similar non-ELs across the state to become CTE concentrators, defined as enrolling in CTE coursework for two years (20% of Non-ELs concentrate in CTE). In columns 2 and 3, we report results from models with school-by-cohort fixed effects, run separately for comprehensive high schools and RVTS. If disparities in concentration were largely attributable to fewer CTE opportunities at the schools ML-ELs attend, we would expect differences to disappear when we compare students within the same school. Instead, in column 2, we estimate that secondary ML-ELs at comprehensive high schools are 5 percentage points less likely than classmates to concentrate in CTE (11% of Non-ELs at comprehensive high schools concentrate). This suggests that differences in concentration are at least partially driven by within school factors. We find little evidence of a disparity in CTE concentration at RVTS, where almost all students become CTE concentrators. Appendix Table A1 reports full results for all covariates.

Table 2. *Association between EL-Subgroup and CTE Engagement.*

	(1) Statewide	(2) Comprehensive	(3) RVTS
Panel A			
CTE Concentrator	-0.049***	-0.045***	-0.020
	(0.015)	(0.009)	(0.010)
	1,021,450	925,846	94,157
Panel B			
Logged Credits	-0.261***	-0.129***	-0.053
	(0.054)	(0.014)	(0.032)
	428,926	379,241	49,100
Fixed Effects	Cohort	School-by-Cohort	School-by-Cohort

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. Estimates are the difference in CTE engagement associated with being a high school ML-EL, relative to never ELs. All models include student-level covariates. Model 1 includes cohort fixed effects. Model 2 is limited to students who attended a comprehensive high school as their primary high school and includes school-by-cohort fixed effects. Model 3 is limited to students who attended an RVTS as their primary high school and includes school-by-cohort fixed effects. Logged credits analysis is limited to CTE participants and 2011-2019 cohorts due to data availability. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. CTE Concentrator=Student who completed at least two years of CTE coursework. RVTS=Regional Vocational Technical School. Comprehensive=Comprehensive High School.

CTE Credit Accumulation

While concentration is one important indicator of exposure to CTE, research suggests that students accrue the greatest benefits from taking multiple CTE courses, particularly upper-level classes (Kreisman & Stange, 2017). In Table 2 Column 1 Panel B, we show that among CTE participants, EL status is associated with earning 23% fewer CTE credits. The typical non-EL CTE participant earns 9 credits, so this is the equivalent of about 2 fewer courses for the average student. Again, if this disparity is related to differences in course offerings between schools, it should disappear when we compare students at the same school. In column 5, we estimate that ML-EL CTE participants at comprehensive high schools earn 12% fewer credits than non-EL classmates, the equivalent of 1 course for the average student at a comprehensive high school. Thus, the difference shrinks but does not disappear when we add school-by-cohort fixed effects, suggesting that differences in intensity of CTE participation may be related to both variation in the number of courses available across schools and within school barriers. In Appendix Table D4, we show descriptively that there is a negative association between the percentage of students at a school who are EL-classified and the average number of years a CTE participant is enrolled in CTE, lending support to the idea that schools that serve more ML-ELs may offer fewer CTE courses overall, particularly upper-level courses. We find little evidence of credit disparities at RVTS. Appendix Table A2 reports full results with all covariates.

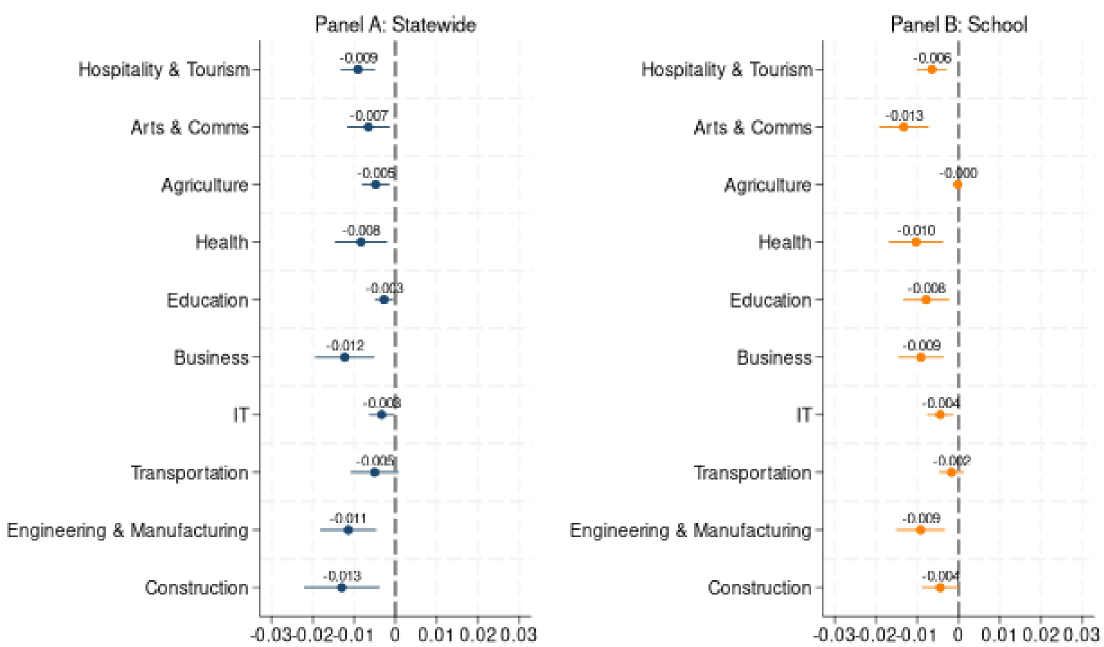
CTE Cluster Concentration

In Figure 1 we assess whether ML-ELs in CTE are less likely than never ELs to concentrate in specific CTE career clusters. Each point estimate shows the difference in the likelihood of concentrating in a given career cluster for high school ML-ELs, relative to never ELs. Students who concentrated in clusters other than the one under study are excluded from the sample for this analysis.

Point estimates in Figure 1 Panel A come from equation 1, which does not include school fixed effects. Comparing students across the state, we estimate that ML-ELs are slightly less likely than never ELs to become concentrators in most clusters. Specifically, ML-ELs are about 1 percentage point less likely to become concentrators in hospitality and tourism (1.3% of never ELs concentrate), arts and communications (1.7%), health science (1.7%), business (2.1%), engineering and manufacturing (2.3%), and construction (3%). Lower likelihood of concentrating in business, engineering/manufacturing, and construction is notable because these are clusters with high average earnings for graduates in the years after high school.

Point estimates in Figure 1 Panel B come from equation 2, which adds school-by-cohort fixed effects. When comparing students within the same schools, the disparity in construction cluster concentration attenuates, suggesting that differences in CTE construction coursework by ML-EL status may be largely explained by the CTE courses that are available at the schools which ML-ELs disproportionately attend. In contrast, estimated disparities in concentration are slightly larger for arts and communication and health science clusters, suggesting that differences in concentration for these clusters may be partially driven by within school factors. Appendix Table A3 reports full results.

Figure 1. *Association between EL Status and the Likelihood of Concentrating in Each Cluster.*



Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade and concentrators in other clusters are excluded. Estimates are the difference in likelihood of concentrating in each CTE career cluster associated with being a High School EL, relative to never ELs. Career clusters are in ascending order by average earnings returns 7 years after expected high school graduation. All models include student-level controls. Panel B adds school-by-cohort fixed effects.

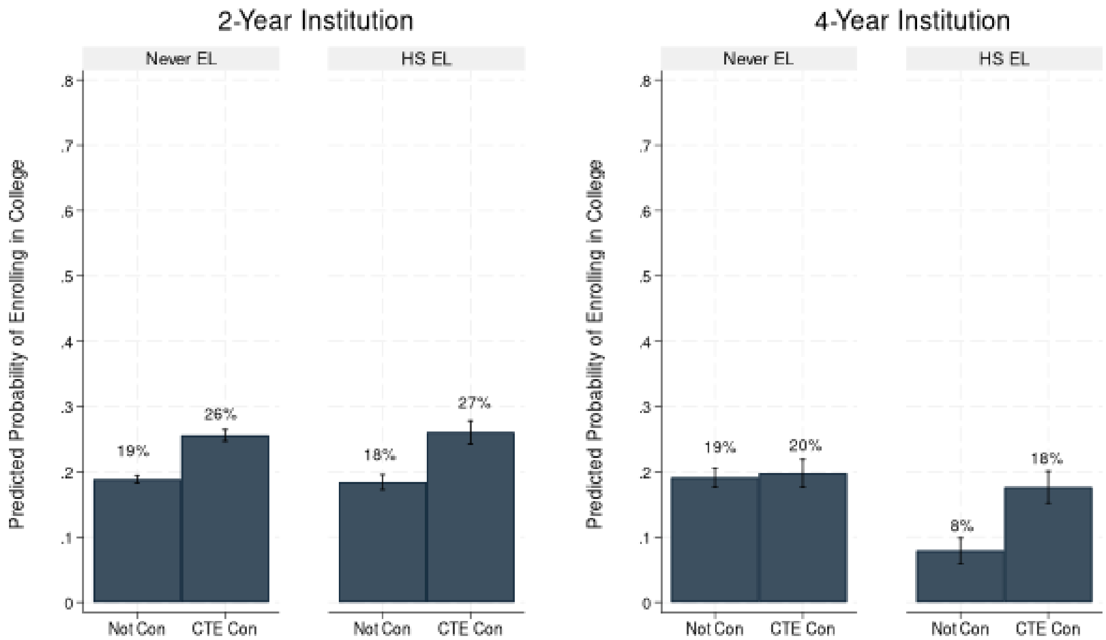
RQ2: Association between CTE Engagement and Postsecondary Educational Outcomes

We next consider the association between our three measures of CTE engagement (concentration, credit accumulation, and cluster concentration) and students' postsecondary outcomes. For ML-EL concentrators, we find a strong positive association between CTE concentration and postsecondary enrollment in both 2-year and 4-year institutions that increases with higher CTE credit completion.

CTE Concentration

Figure 2 shows the predicted probability of postsecondary enrollment in 2-year and 4-year institutions by CTE concentration and EL status for a student with the characteristics of the typical ML-EL in the sample. We estimate that never EL CTE concentrators are about 7 percentage points more likely than non-concentrator peers to enroll in a 2-year postsecondary institution, but no more likely to enroll in a 4-year institution. In contrast, we find that ML-EL concentrators are more likely to enroll in both types of institutions. Figure 2 suggests that ML-EL CTE-concentrators are 9 percentage points more likely to enroll in a 2-year institution and 10 percentage points more likely to enroll in a 4-year institution. Appendix Table B1 shows that CTE concentration is associated with a significant increase in four-year enrollment for high school ML-ELs but not for never EL peers.

Figure 2. *Association between CTE Concentration and Postsecondary Outcomes, by ML-EL Status.*

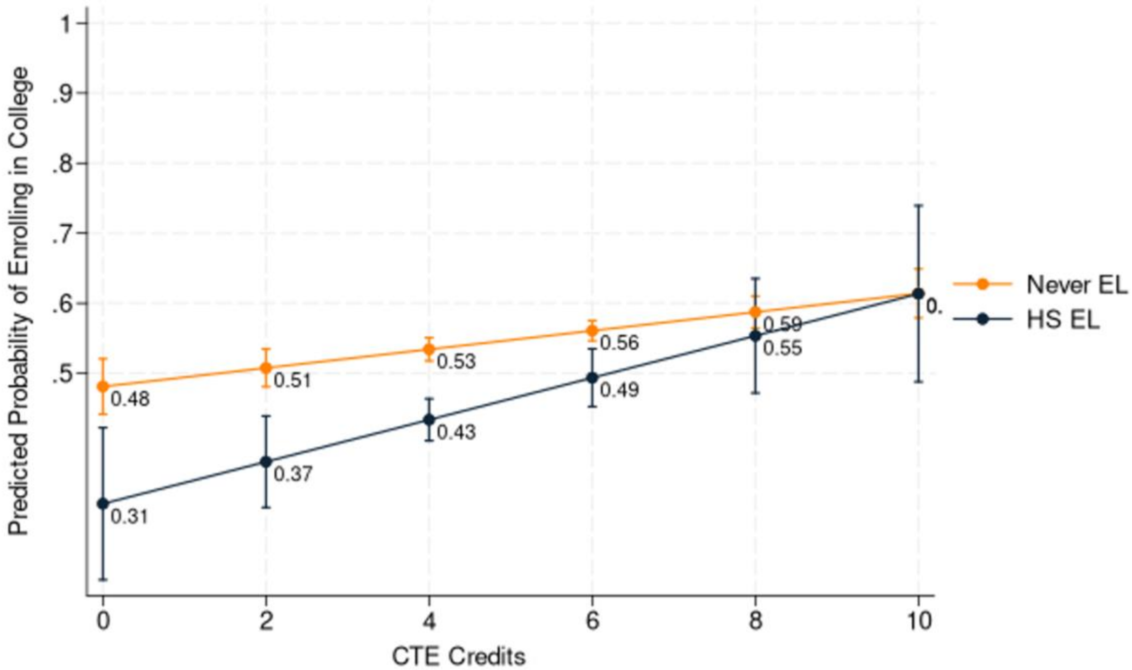


Note: Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; former ELs who reclassified before 9th grade are excluded. Estimates are the predicted probability of postsecondary enrollment by CTE concentrator and EL status for a student with the characteristics of the typical ML-EL in the sample. Con=CTE Concentrator, defined as completing at least 2-years of CTE coursework.

CTE Credit Accumulation

In Figure 3, we show the predicted probability of any postsecondary enrollment at different levels of CTE credit accumulation, for a student with the characteristics of a typical ML-EL in the sample. For both non-ELs and high school ML-ELs, we estimate that the predicted probability of postsecondary enrollment increases with credit accumulation (Full Results in Appendix Table B2).

Figure 3. *Association between CTE Credit Accumulation and Predicted Probability of Any Postsecondary Enrollment.*

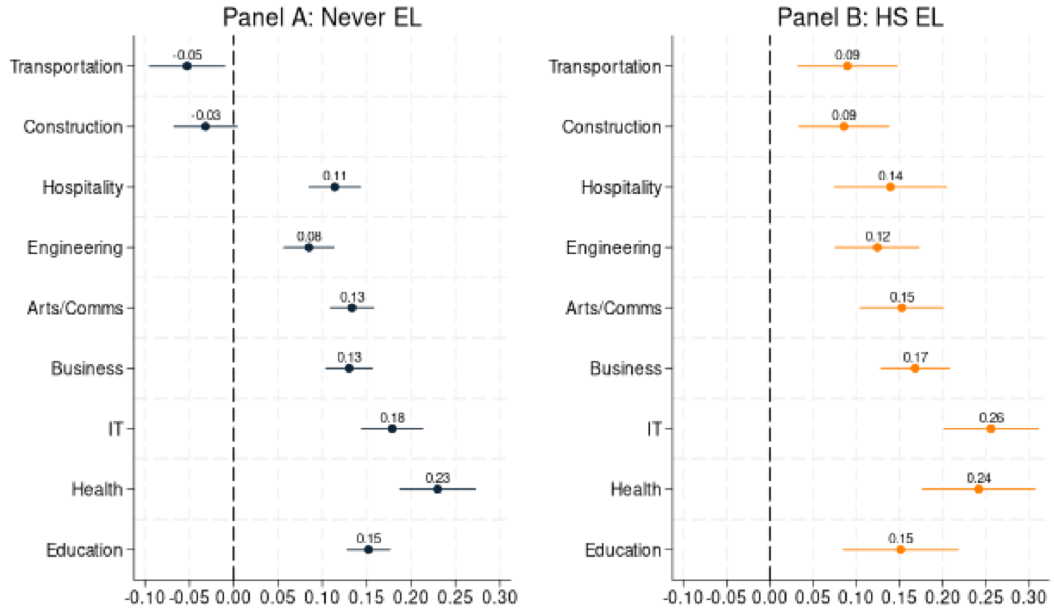


Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; former ELs who reclassified before 9th grade are excluded. Estimates are the predicted probability of any postsecondary enrollment by spring 2019 at each level of CTE credit accumulation for a student with the characteristics of the typical ML-EL in the sample. All models include student-level controls.

CTE Cluster Concentration

Finally, Figure 4 shows the change in likelihood of any postsecondary enrollment for concentrators in each cluster. Panel A shows the associations between cluster concentration and postsecondary enrollment for never ELs and demonstrates that transportation and construction clusters are associated with a small decrease in the likelihood of enrolling in college. In contrast, for ML-ELs, concentrating in any of the 11 clusters is associated with increased likelihood of enrolling in college. For both never ELs and ML-ELs, the health science and IT clusters are associated with large increases in the likelihood of postsecondary enrollment. Appendix Table B3 reports full results.

Figure 4. *Association between Cluster Concentration and the Likelihood of Any Postsecondary Enrollment for ML-EL Concentrators relative to ML-EL Non-Concentrators.*



Note. Panel A is limited to never ELs and Panel B is limited to high school ML-ELs. Estimates are the difference in likelihood of postsecondary enrollment associated with being a concentrator, relative to non-concentrators. Career clusters are in ascending order by percentage of all concentrators who enroll in postsecondary education. All models include student-level controls and school-by-cohort fixed effects.

RQ3: Association between CTE Engagement and Labor Market Outcomes

We next consider the relationship between CTE and annual earnings. This analysis is limited to people who reported any earnings in each year. We find a strong positive association between CTE concentration and earnings up to 7 years after expected high school graduation for never ELs. Earnings advantages for ML-EL CTE concentrators appear to be smaller, but still practically large. The earnings benefits of CTE participation are particularly large for students who do not earn a college degree.

CTE Concentration

In Table 3, we show that CTE concentrators consistently earn more than similarly achieving non-concentrators in the years after expected high school graduation. For example, among students without a college degree, Never EL CTE concentrators are predicted to earn 27% more than non-concentrator peers seven years after high school. The typical never EL non-concentrator without a college degree earns $29,782 annually by this point, meaning that CTE concentrators earn around $8,000 more a year on average. Among students with a college degree, Never EL concentrators earn 9% more seven years after high school. The typical Never EL non-concentrator with a college degree earns $43,579 annually by this point, meaning that CTE concentrators earn more than $4,000 more a year on average.

Negative interaction terms suggest a smaller earnings advantage for ML-EL concentrators, particularly immediately following high school. Nevertheless, our results indicate that ML-EL concentrators earn substantially more on average than otherwise similar ML-ELs who did not concentrate in CTE. Point estimates in Table A4 also suggest that CTE earnings advantages shrink slightly over time (Kreisman & Stange, 2017).

Table 3. *Association between CTE Concentration and Mean Annual Earnings (Logged), By Years after expected high school graduation.*

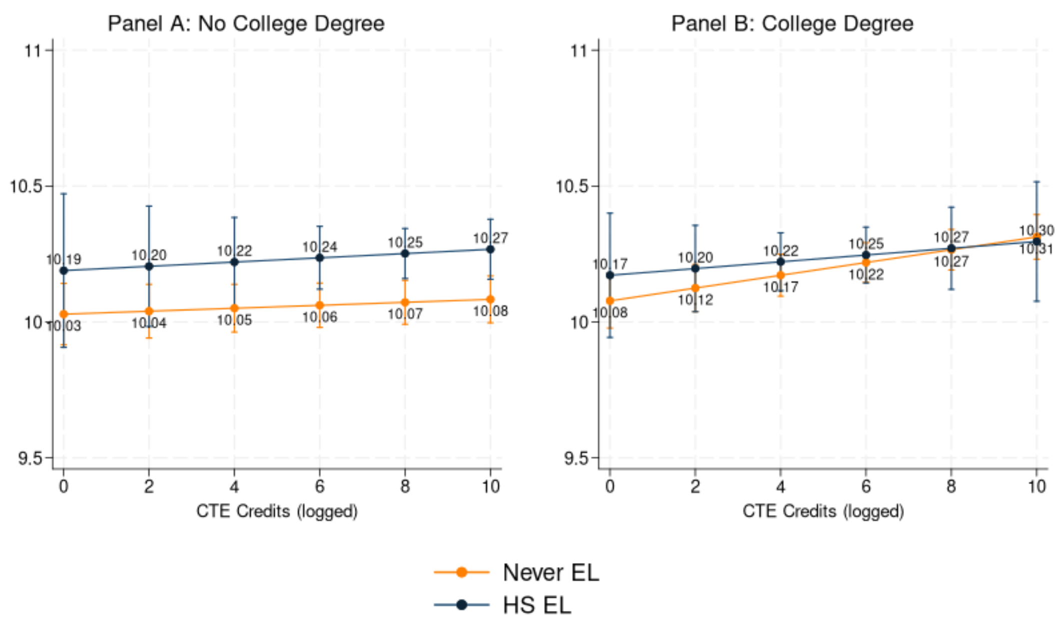
	(1) 3yr	(2) 5yr	(3) 7yr
No College Degree			
CTE Concentrator	0.32^{***}	0.28^{***}	0.24^{***}
	(0.017)	(0.016)	(0.014)
CTExEL			
	-0.10^{*}	-0.09	0.01
	(0.041)	(0.051)	(0.033)
	153909	157205	154357
College Degree	0.15^{***}	0.13^{***}	0.09^{***}
CTE Concentrator	(0.014)	(0.015)	(0.015)
CTExEL	-0.09^{*}	-0.05	-0.03
	(0.040)	(0.040)	(0.037)
	177518	179084	169709

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012 who reported any earnings to the UI system. Estimates are the difference in average annual earnings (logged). All models include student-level controls and school-by-cohort fixed effects.

CTE Credit Accumulation

Figure 5 shows predicted annual earnings (logged) 7 years after expected graduation by total number of completed CTE credits for CTE participants. Regardless of whether a student earned a college degree, predicted earnings increase with CTE credit completion. Appendix Table C1 reports full results.

Figure 5. *Association between CTE Credit Accumulation and Predicted Annual Earnings (Logged) 7 Years After Expected High School Graduation, Among CTE Participants.*



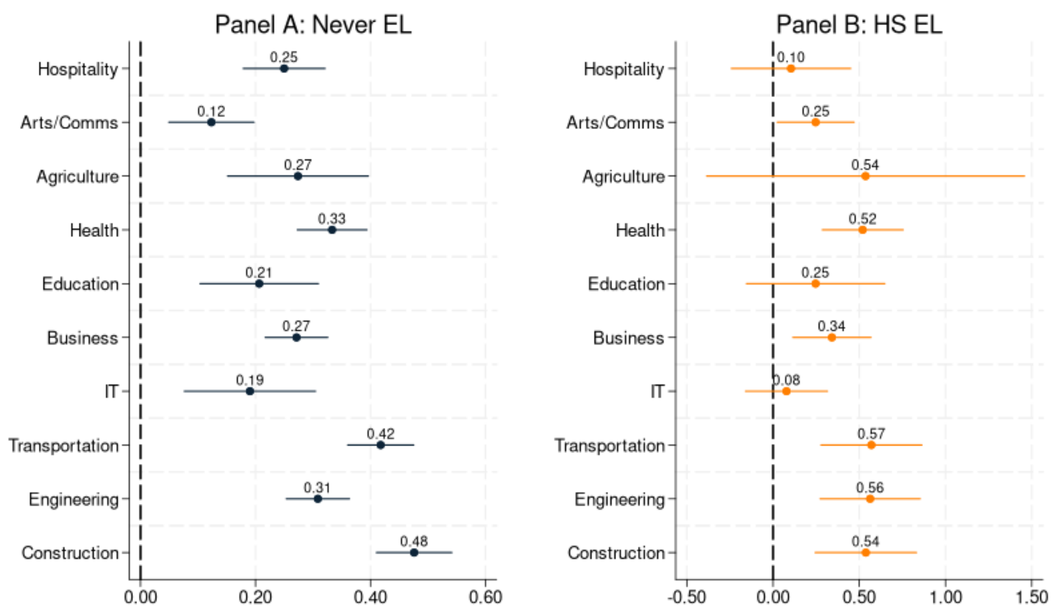
Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012 who reported any earnings to the UI system. Estimates show predicted annual earnings for a student with the characteristics of the typical ML-EL in the sample. All models include student-level controls and school-by-cohort fixed effects. Higher predicted earnings for ML-ELs likely reflect non-reporting bias given that ML-ELs are less likely to report earnings to the UI system.

CTE Cluster Concentration

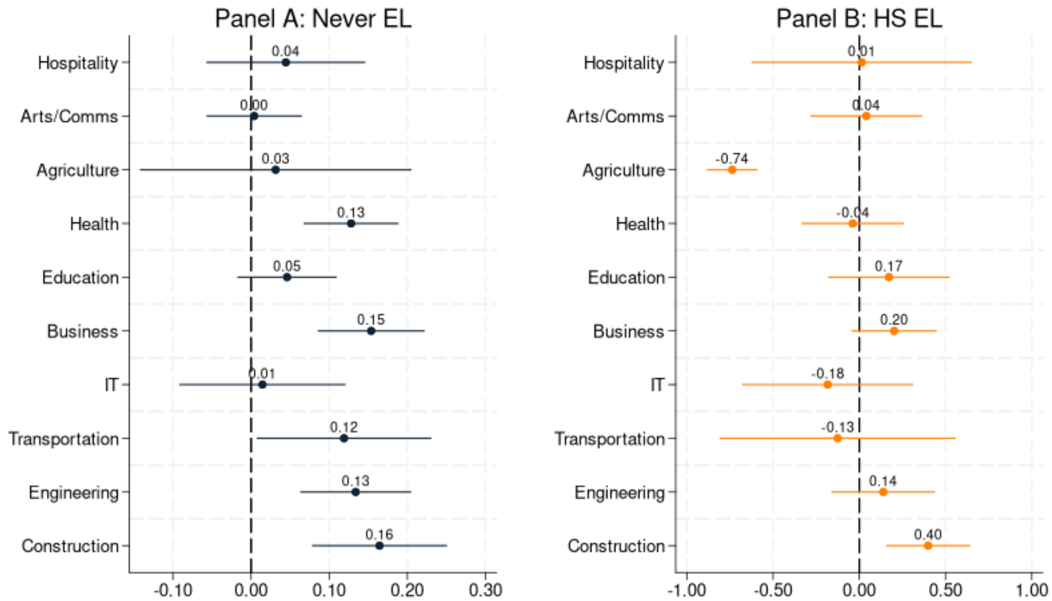
Finally, in Figure 6, we show the estimated difference in 7-year average annual earnings (logged) by concentrator status and postsecondary attainment for never ELs without a college degree, CTE concentrators are predicted to earn substantially more regardless of which cluster they concentrated in, with the highest returns for transportation, engineering/manufacturing, and construction. For high school ML-ELs, only some clusters are associated with earnings advantages. Among students without a college degree, those who concentrate in health, business, transportation, engineering/manufacturing, and construction are all predicted to earn substantially more than similar peers who did not concentrate in CTE. Among students with college degrees, the benefits of CTE concentration are less consistent. Several clusters are associated with increased earnings for never ELs; only construction is associated with higher earnings for ML-ELs with college degrees, relative to no CTE concentration. Appendix Table C2 reports full results.

Figure 6. *Association between CTE Cluster Concentration and Predicted Annual Earnings (Logged) Among ML-ELs.*

No College Degree



College Degree



Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012 who reported any earnings to the UI system. Estimates are the difference in likelihood of postsecondary enrollment associated with being a cluster concentrator, relative to not concentrating in CTE. Career clusters are in ascending order by average earnings. All models include student-level controls and school-by-cohort fixed effects.

Limitations

A primary limitation of our analysis is the potential for selection bias. In our first set of analyses, there is a strong possibility that unobserved characteristics influence both EL status and the likelihood of participating in CTE. In the second set, the concern is that some characteristics may affect both CTE concentration and our outcomes of interest. To partially address this, we include school-by-cohort fixed effects, as well as controls for observable demographic and prior achievement characteristics.[7] Nevertheless, our analysis cannot account fully for endogeneity. Our evidence of a positive association between CTE participation and long-term success for English learners in Massachusetts provides an initial data point to guide policymakers as they work to meet federal requirements to ensure equitable access to CTE for ML-ELs.

Discussion and Conclusion

CTE Participation for ML-ELs

In line with prior literature suggesting that EL status can constrain access to secondary courses (Callahan, 2005; Kangas & Cook, 2020), we find that English learners in Massachusetts are less likely to engage in CTE across multiple dimensions: concentration, credit accumulation, and cluster concentration. In particular, we estimate large disparities in the intensity of CTE participation for ML-ELs relative to never EL concentrator peers. Provisions in the 2006 and 2018 reauthorizations of the Perkins Act require states to identify and address gaps in CTE engagement for English learners. Our findings suggest that after accounting for characteristics like prior achievement and family income, ML-ELs in Massachusetts may face additional barriers to CTE engagement.

In Massachusetts and other states with disparities in CTE engagement by EL status, leaders can address gaps by drawing on funds from Perkins V and Title III of the Every Student Succeeds Act, which both identify recruiting and supporting ML-ELs in CTE as an allowable use of funds (Sugarman, 2023; Supporting English Learners in Career Technical Education, 2024). Our findings are consistent with two types of disparities in CTE engagement for ML-ELs: less access between schools and less participation within schools. Leaders can address between-school disparities by expanding offerings in schools that serve large ML-EL populations; increasing the availability of upper-level courses within specific career clusters is particularly important (Kreisman & Stange, 2017). Our results suggest that, before accounting for opportunity within schools, ML-ELs are slightly less likely to concentrate in construction—a field with high earnings returns. Districts should consider addressing gaps by adding more high-return programs at schools with a large population of ML-ELs and by adding more CTE programs that build on English learners' linguistic assets, such as courses in translation and interpretation or programs aligned with the needs of local businesses that are seeking multilingual employees (Sugarman, 2023).

We also find that ML-ELs are less likely to concentrate in CTE than classmates within the same comprehensive high schools. Prior literature identifies two mechanisms that could explain this gap: scheduling constraints due to English language development requirements and lack of encouragement from school staff. Further research should explore these and other factors to identify the most persistent barriers to CTE participation for ML-ELs. Using Perkins funding to offer CTE on a flexible schedule, such as in the mornings or evenings or on a weekly rotating schedule, is one strategy to address logistical barriers to participation for ML-ELs (Sugarman, 2023). Professional development for guidance counselors, CTE teachers, and EL educators around the potential benefits of CTE for ML-ELs can empower school staff to encourage ML-ELs to consider CTE coursework (Kanno & Kangas, 2014; Supporting English Learners in Career Technical Education, 2024).

Addressing Long-Term Outcomes for ML-ELs

Although postsecondary outcomes for students who are EL-classified in high school lag behind those of non-EL peers, there is a dearth of empirical evidence around strategies that states can use to improve trajectories for language learners (Johnson & Mercado-Garcia, 2022; Kanno & Cromley, 2013; Núñez et al., 2016). Interpreted in the context of other research about the effects of CTE, our findings suggest that expanding access to career and technical education may be a promising strategy for improving long-term outcomes for ML-ELs. For example, causal studies of selective CTE high schools (Brunner et al., 2023; Dougherty, 2018), CTE career academies (Hemelt et al., 2019), and CTE at comprehensive high schools (Bonilla, 2020) demonstrate that career courses increase educational attainment for marginalized students across different state and program contexts. Across multiple specifications, our findings suggest that the positive relationship between CTE and postsecondary outcomes may also hold for English learners. While the research base linking CTE to improved postsecondary outcomes is still developing, our finding that CTE concentration is associated with higher four-year enrollment and attainment for ML-EL concentrators, but not for similar non-ELs, is noteworthy. Evidence of a positive association between CTE and postsecondary outcomes for ML-ELs invites further research on how career-focused coursework might uniquely benefit ML-ELs' postsecondary pathways.

Similarly, a large base of causal research indicates that attending CTE high schools or academies substantially increases earnings in the years after graduation (Brunner et al., 2023; Kemple, 2008; Page, 2012). Our findings suggest that earnings advantages may also apply to ML-EL CTE concentrators, particularly those who do not attend any postsecondary education. With over 60% of Massachusetts high school ML-ELs not attending college, increasing CTE participation could be a viable way to support non-college-going ML-ELs more effectively.

Overall, our findings contribute to the growing body of research that documents a positive relationship between CTE and long-term success, suggesting that the benefits of CTE may also extend to English learners. Evidence of disparities in CTE participation by EL status in Massachusetts necessitates more research about CTE engagement for English learners in other contexts, as well as policy action to address gaps in access to career coursework. As states work to better serve ML-ELs, there is a need for more evidence highlighting effective interventions that can facilitate students' postsecondary and labor market success. This paper adds to the literature by identifying CTE as one potential strategy that leaders can leverage to address long-term outcomes for ML-EL students.

Appendix A

Table A1

Association between EL-Subgroup and CTE Concentration

	(1) Statewide	(2) Comprehensive HS	(3) RVTS
HS EL	-0.049***	-0.045***	-0.020
	(0.015)	(0.009)	(0.010)
FRPL	0.105***	0.015***	-0.004
	(0.013)	(0.003)	(0.003)
Female	-0.034***	-0.021***	0.001
	(0.005)	(0.004)	(0.003)
Asian	-0.056***	-0.009	-0.036***
	(0.015)	(0.006)	(0.007)
Hispanic	-0.026	-0.017***	-0.011***
	(0.025)	(0.003)	(0.003)
Native American/Alaskan Native	0.015	-0.005	-0.026
	(0.015)	(0.007)	(0.014)
Black	-0.067**	-0.011**	-0.009
	(0.023)	(0.004)	(0.005)
Mixed Race	-0.004	-0.006**	0.003
	(0.011)	(0.002)	(0.006)
Other Race	-0.055***	-0.001	-0.109
	(0.016)	(0.008)	(0.083)
SPED	-0.012	-0.004	-0.010***
	(0.010)	(0.003)	(0.003)
8th Grade Math Score	-0.058***	-0.012***	0.008***
	(0.006)	(0.002)	(0.001)
8th Grade Attendance	0.465***	0.197***	0.575***
	(0.061)	(0.025)	(0.100)
Missing Attendance	-0.126***	-0.050***	-0.085*
	(0.013)	(0.007)	(0.036)
Missing Math Score	-0.051***	-0.032***	-0.047***
	(0.007)	(0.005)	(0.010)
Not in Data in 8th grade	0.102***	0.017***	0.071*
	(0.012)	(0.005)	(0.034)
Took Alternative MCAS	-0.096***	-0.049***	-0.073*
	(0.014)	(0.008)	(0.034)
N	1,021,450	925,846	94,157
FE		SchoolXCohort	SchoolXCohort

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. Reference category for race is White. Model 1 includes cohort fixed effects. Models 2 is limited students who attended a comprehensive high school as their primary high school and includes school-by-cohort fixed effects. Models 3 is limited to students who attended an RVTS as their primary high school and include school by cohort fixed effects. Logged credits analysis is limited to CTE participants and 2011-2019 cohorts due to data availability.

Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. CTE Concentrator=Student who completed at least two years of CTE coursework. RVTS=Regional Vocational Technical School. Comprehensive=Comprehensive High School.

Table A2

Association between EL-Subgroup and Accumulated CTE Credits (Logged), Among Participants

	(1) Statewide	(2) Comprehensive HS	(3) RVTS
HS EL	-0.261***	-0.129***	-0.053
	(0.054)	(0.014)	(0.032)
FRPL	0.004	-0.012*	-0.060***
	(0.042)	(0.005)	(0.013)
Female	-0.264***	-0.276***	-0.167**
	(0.015)	(0.012)	(0.055)
Asian	-0.240***	-0.051***	-0.109**
	(0.065)	(0.013)	(0.039)
Hispanic	-0.307***	-0.075***	-0.086***
	(0.062)	(0.008)	(0.019)
Native American/Alaskan Native	-0.196*	-0.027	0.026
	(0.081)	(0.029)	(0.078)
Black	-0.491***	-0.101***	-0.107***
	(0.086)	(0.008)	(0.027)
Mixed Race	-0.193***	-0.065***	-0.021
	(0.046)	(0.009)	(0.035)
Other Race	-0.144	-0.100**	0.122
	(0.076)	(0.037)	(0.193)
SPED	-0.037	-0.098***	0.004
	(0.029)	(0.009)	(0.016)
8th Grade Math Score	-0.076***	-0.039***	0.044***
	(0.017)	(0.004)	(0.011)
8th Grade Attendance	1.564***	0.819***	0.937***
	(0.181)	(0.055)	(0.184)
Missing Attendance	-0.302***	-0.135***	-0.072
	(0.044)	(0.016)	(0.057)
Missing Math Score	-0.071	-0.046***	-0.024
	(0.040)	(0.010)	(0.046)
Not in Data in 8th grade	0.186***	-0.006	0.101
	(0.050)	(0.017)	(0.052)
Took Alternative MCAS	-0.086	-0.028	-0.183
	(0.058)	(0.028)	(0.101)
N	428,926	379,241	49,100
FE		SchoolXCohort	SchoolXCohort

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. Reference category for race is White. Estimates are the difference in CTE engagement associated with being a high school ML-EL, relative to never ELs. Model 1 includes cohort fixed effects. Models 2 is limited students who attended a comprehensive high school as their primary high school and includes school-by-cohort fixed effects. Models 3 is limited to students who attended an RVTS as their primary high school and include school by cohort fixed effects. Logged credits analysis is limited to CTE participants and 2011-2019 cohorts due to data availability. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. CTE Concentrator=Student who completed at least two years of CTE coursework. RVTS=Regional Vocational Technical School. Comprehensive=Comprehensive High School.

Table A3

Association between EL Status and Cluster Concentration

	(1) Statewide	(2) Within School
Agriculture	-0.005^{**}	-0.000
	(0.002)	(0.000)
	875,169	873,714
Arts/Comms	-0.007^{*}	-0.013^{***}
	(0.003)	(0.003)
	885,097	883,637
Business	-0.012^{***}	-0.009^{***}
	(0.004)	(0.003)
	889,394	887,948
Construction	-0.013^{**}	-0.004^{*}
	(0.005)	(0.002)
	897,920	896,470
Education	-0.003^{**}	-0.008^{**}
	(0.001)	(0.003)
	876,538	875,070
Health	-0.008^{**}	-0.010^{**}
	(0.003)	(0.003)
	883,329	881,879
Hospitality	-0.009^{***}	-0.006^{***}
	(0.002)	(0.002)
	881,572	880,119
IT	-0.003^{*}	-0.004^{**}
	(0.001)	(0.002)
	876,709	875,261
Engineering/Manufacturing	-0.011^{***}	-0.009^{**}
	(0.003)	(0.003)
	890,864	889,415
Transportation	-0.005	-0.002
	(0.003)	(0.001)
	884,970	883,523

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade and concentrators in other clusters are excluded. Estimates are the likelihood of concentrating in cluster relative to no CTE, for ML-ELs compared to never ELs. Model 1 includes cohort fixed effects. Models 2 include school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B

Table B1

Association between EL Status, CTE Concentration, and Postsecondary Educational Outcomes

	(1) HS Grad	(2) Ever Enroll PSE	(3) Enroll 2yr	(4) Enroll 4yr	(5) Ever Grad PSE	(6) Grad 2yr
CTE Con	0.21***	0.07***	0.07***	0.01	0.05***	-0.00
	(0.010)	(0.010)	(0.005)	(0.010)	(0.004)	(0.006)
HS EL	-0.08***	-0.12***	-0.00	-0.11***	-0.01	-0.02***
	(0.009)	(0.009)	(0.005)	(0.009)	(0.004)	(0.004)
CTE Con X EL	0.09***	0.10***	0.01	0.09***	0.01*	0.04***
	(0.011)	(0.012)	(0.009)	(0.011)	(0.007)	(0.007)
Observations	1020004	1020004	1020004	1020004	1020004	1020004

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B2

Association between EL Status, CTE Credit Accumulation, and Any Postsecondary Enrollment, Among CTE Participants

	(1) PSE Ever
Total CTE Credits Earned	0.02***
	(0.004)
HS ELxTotal CTE Credits	0.02
	(0.012)
CTE Credits^2	-0.01
	(0.005)
Observations	456519

Note. Analytic sample includes students with any CTE participation enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B3

Association between Cluster Concentration and Likelihood of Any Postsecondary Enrollment

	(1) Never EL	(2) HS EL
Agriculture	0.06	0.16
	(0.034)	(0.102)
	805668	67126
Arts/Comms	0.13***	0.15***
	(0.012)	(0.024)
	814635	68074
Business	0.13***	0.17***
	(0.013)	(0.020)
	818894	68124
Construction	-0.03	0.09**
	(0.018)	(0.026)
	827402	68132
Education	0.15***	0.15***
	(0.012)	(0.034)
	806704	67440
Health	0.23***	0.24***
	(0.022)	(0.033)
	812837	68108
Hospitality	0.11***	0.14***
	(0.015)	(0.033)
	811523	67665
IT	0.18***	0.26***
	(0.018)	(0.028)
	806833	67496
Engineering	0.08***	0.12***
	(0.014)	(0.025)
	820378	68100
Transportation	-0.05*	0.09**
	(0.022)	(0.029)
	814442	68138

Note. Analytic sample includes students with any CTE participation enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix C

Table C1

Association between Credit Accumulation and Earning, Among CTE Participants

	(1) 3yr Post	(2) 5yr Post	(3) 7yr Post
Total CTE Credits Earned	0.03^{***}	0.03^{***}	0.04^{***}
	(0.002)	(0.002)	(0.003)
HS EL x Total CTE Credits	0.00	0.00	0.03^{*}
	(0.008)	(0.009)	(0.011)
CTE Credits^2	-0.00^{***}	-0.00^{***}	-0.00^{***}
	(0.000)	(0.000)	(0.000)
Observations	334758	220508	107774

Note. Analytic sample includes students with any CTE participation and any reported earnings who enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table C2

Association Between Cluster Concentration and Logged Earnings, Among ML-ELs

	(1) Never EL	(2) HS EL
Transportation	0.34***	0.46***
	(0.027)	(0.128)
	247421	11800
Agriculture	0.22***	0.38
	(0.052)	(0.605)
	243970	11562
Arts/Comms	0.10***	0.16
	(0.027)	(0.111)
	246354	11762
Business	0.24***	0.29***
	(0.022)	(0.084)
	248372	11783
Construction	0.39***	0.50***
	(0.031)	(0.113)
	252928	11803
Education	0.16***	0.15
	(0.031)	(0.100)
	244215	11615
Health	0.27***	0.26*
	(0.023)	(0.112)
	246224	11795
Hospitality	0.18***	0.03
	(0.030)	(0.127)
	245771	11656
IT	0.15***	0.03
	(0.039)	(0.102)
	244329	11653
Engineering	0.26***	0.47***
	(0.022)	(0.087)
	248993	11756

Note. Analytic sample includes students with any reported earnings who enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table C3

Association Between Concentration, EL Status and Logged Annual Earnings, Zero Earnings Included

	(1) 3yr	(2) 5yr	(3) 7yr
No College Degree			
CTE Concentrator	1.25***	1.31***	1.25***
	(0.050)	(0.049)	(0.053)
CTExEL			
	-0.08	-0.10	-0.00
	(0.136)	(0.141)	(0.151)
	447917	338953	264261
College Degree	0.50***	0.42***	0.36***
CTE Concentrator	(0.036)	(0.046)	(0.056)
CTExEL	-0.19	-0.26*	-0.33*
	(0.110)	(0.130)	(0.162)
	373655	324486	240026

Note. Analytic sample includes students who enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012; Former ELs who reclassified before 9th grade are excluded. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix D

Table D1

Association between EL Status and Reporting Zero Earnings

	(1) 3yr	(2) 5yr	(3) 7yr	(4) Any
ML-EL	0.21***	0.20***	0.17***	0.15***
	(0.003)	(0.003)	(0.003)	(0.003)
	499248	499248	499248	499248

Note. Analytic sample includes students who enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012; Former ELs who reclassified before 9th grade are excluded. Estimates show the difference in likelihood of reporting 0 earnings (neither true 0 nor missing) associated with being a high school ML-EL. All models include student-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table D2

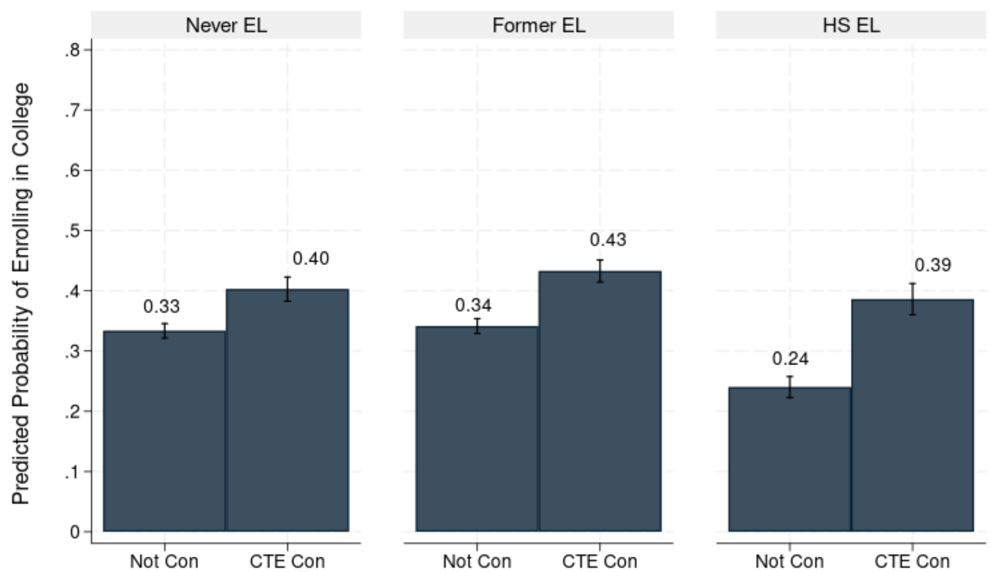
Association between Former EL Status and CTE Engagement

	(1) Statewide	(2) Comprehensive	(3) RVTS
Panel A			
CTE Concentrator	0.048**	0.011**	0.009*
	(0.017)	(0.004)	(0.004)
	987,759	890,570	95,735
Panel B			
Logged Credits	0.027	0.026***	-0.048
	(0.046)	(0.007)	(0.028)
	431,293	379,518	51,191
Fixed Effects	Cohort	School-by-Cohort	School-by-Cohort

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019. Estimates are the difference in CTE engagement associated with being a former EL who reclassified before 9th grade, relative to never ELs. All models include students-level covariates. Model 1 includes cohort fixed effects. Models 2 is limited students who attended a comprehensive high school as their primary high school and includes school-by-cohort fixed effects. Models 3 is limited to students who attended an RVTS as their primary high school and include school by cohort fixed effects. Logged credits analysis is limited to CTE participants and 2011-2019 cohorts due to data availability. Standard errors are clustered at the school level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. CTE Concentrator=Student who completed at least two years of CTE coursework. RVTS=Regional Vocational Technical School. Comprehensive=Comprehensive High School.

Figure D1

Predicted Probability of Any Postsecondary Enrollment by EL Status and CTE Concentration



Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019. Estimates show the predicted probability of any postsecondary enrollment by EL status and CTE concentrator status for a student with the characteristics of a typical ML-EL in the sample. All models include students-level covariates and school-by-cohort fixed effects. Standard errors are clustered at the school level.

Table D3

Association between CTE Concentration and Mean Annual Earnings (Logged), By Years after expected high school graduation

	(1) 3yr	(2) 5yr	(3) 7yr
No College Degree			
CTE Concentrator	0.32***	0.28***	0.24***
	(0.016)	(0.016)	(0.014)
CTExFormer EL			
	0.03	-0.10	-0.04
	(0.072)	(0.055)	(0.057)
	145092	147822	144840
College Degree	0.15***	0.13***	0.09***
CTE Concentrator	(0.014)	(0.014)	(0.015)
CTEx Former EL	-0.04	-0.04	-0.08
	(0.051)	(0.053)	(0.051)
	172354	173669	164443

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2012 who reported any earnings to the UI system. Estimates are the difference in average annual earnings (logged). All models include student-level controls and school-by-cohort fixed effects.

Table D4

Average HS CTE Course Offerings by the Percentage of Students who are High School ML-ELs

Percentage of Student Body Who are HS ML-ELs	Mean CTE Clusters Offered	Average Years Enrolled in Cluster, Among CTE Participants
0%	0.5	1.2
1-10%	1.2	1.2
10-20%	3.0	1.1
20-50%	2.8	0.87
>50%	0.6	0.64

Note. Analytic sample includes students enrolled in public schools in Massachusetts at any point in grades 9-12 with expected high school graduation years from 2007-2019.